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PACIFIC NORTH WEST
U. S. FOREST SERVICE
Research Note
FOREST AND RANGE EXPERIMENT STATION • U.S. DEPARTMENT OF AGRICULTURE • PORTLAND, OREGON

PNW-63 September 1967

PACIFIC SOUTHWEST FOREST AND RANGE
EXPERIMENT STATION
P. O. BOX 245
BERKELEY 1, CALIFORNIA

A COMPUTER PROGRAM FOR CALCULATING ALLOWABLE CUT USING AREA REGULATION AND A COMPARISON WITH THE ARVOL METHOD

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INTRODUCTION

Volume regulation is the method most commonly applied to schedule harvest cuts in old-growth Douglas-fir stands in Oregon and Washington National Forests (e.g., it is used on all but one National Forest working circle at the present time). Area regulation also has a place in management planning as a scheduling method and is finding increased interest among forest managers and timberland owners whose main objective is to annually cut an equal forest area.

Recently, a computer program was written that schedules the allowable cut using area regulation. This program, entitled AREA, is a useful analytical companion to the ARVOL program, which was developed earlier to calculate allowable cut using volume regulation.[1]

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[1] Chappelle, Daniel E. A computer program for calculating allowable cut using the area-volume check method. Pacific Northwest Forest & Range Exp. Sta., U.S. Forest Serv. Res. Note PNW-44, 4 pp. 1966. Both ARVOL and AREA are products of the Timber Management Decision Systems (TIMADS) Study. TIMADS, a continuing research effort of the Station and the Pacific Northwest Region, is a long-term study designed to provide forest managers with a more effective planning system.

Use of these two programs can help management planners more efficiently assess the appropriateness of applying volume or area regulation to particular forest tracts.[2]

DESCRIPTION OF THE AREA PROGRAM

There are six distinct steps required in the use of the area regulation method. The AREA program, coded in FORTRAN IV, for an IBM 7040 installation, incorporates these steps in computing the allowable cut.

1. Evaluate age class data for the forest in order of cutting priority. This generally means arranging forest stand data by decreasing age.[3]
2. Calculate the total area of all stands.
3. Calculate the area to cut each year.
4. Calculate the time required to harvest each stand.
5. Calculate age of stand and yield of stand when cut.
6. Calculate the average annual cut and the cut for each year of the rotation.

In the AREA program the area to cut annually can be calculated with ease once total area and rotation length are known. The years required to cut a given stand are then directly calculated by dividing stand area by acres to be cut annually. In contrast, in ARVOL the allowable cut is calculated in an iterative fashion because it varies directly with the yield of the age class at time of harvesting. The yield of any age class, in turn, depends on age of stands when cut, and the age when cut depends on the cumulated years required to cut the stands. Therefore, a convergence is required to calculate a trial cut that will balance the above factors.

Users of ARVOL should note that input data for ARVOL are interchangeable with AREA. Also, the format of AREA output is nearly identical with ARVOL output, the major exception being that average volume cut for each year of the rotation is shown in a separate table.

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[2] Area and volume regulation are not the only methods employed in scheduling harvesting operations. The appropriateness of any particular method, of course, depends on how adequately it furthers the firm's goals.

[3] Each age class is considered to be a stand. However, it is possible that several stands could be the same age.

The program is designed to evaluate a range of alternative rotation lengths. In addition, separate problems, each of which may include the analysis of several alternative rotation lengths, may be stacked and run at one time.

Typical operating times for AREA are as follows:

Number of age classes	Intensive management	Number of alternative rotation lengths	Execution time[1/]
			(Minutes)
25	Yes	1	0.40
25	Yes	23	1.05
25	Yes	46	1.75

[1/] Does not include program compilation time.

COMPARISON OF AREA AND ARVOL METHODS

The area regulation method can be contrasted with volume regulation in two important ways:

1. Volume regulation provides for a constant allowable cut over a rotation period, but the acreage cut per year and, hence, the regenerated acreage per year may vary substantially. In contrast, area regulation provides for an equal acreage cut annually, but the volume cut per year will vary substantially unless the forest is fully regulated.

2. Area regulation provides for an even distribution of area among rotation and younger age classes after one rotation period (i.e., the forest will be fully regulated). In contrast, under volume regulation after one rotation period, considerable concentration of area may be present in some age classes equal to or less than rotation length in age.

In order to exemplify the AREA and ARVOL methods, a sample problem was run with both computer programs using the area and age class arrays in table 1, and assuming a 100-year rotation with a 5-year regeneration period. In this example, 82 percent of the total forest area contains timber above rotation age at the beginning of the plan period, and certain intermediate age classes are nonexistent. The sample problem output revealed that under volume regulation, old-growth timber (i.e., over rotation age) is harvested in 98 years (see column 9, table 1) and in 97 years under area regulation (see column 5, table 1). Therefore, nearly the entire planned rotation may be considered a period of conversion from old-growth timber to young-growth timber under both regulation methods.

Table 1.--Computer output from AREA and ARVOL programs

Age class	Area	AREA (area regulation)				ARVOL (volume regulation)			
		Yield per acre (3)	Time required to cut (4)	Sum of time required to cut (5)	Average age when cut (6)	Yield per acre (7)	Time required to cut (8)	Sum of time required to cut (9)	Average age when cut (10)
(1)	(2)								
Years	Acres	Bd. ft.	---------- Years ----------			Bd. ft.	---------- Years ----------		
300	20,000	65,000	18.2	18.2	309	65,000	21.7	21.7	311
250	15,000	60,000	13.6	31.8	275	60,000	15.0	36.7	279
200	20,000	55,000	18.2	50.0	241	55,000	18.3	55.0	246
180	13,000	52,910	11.8	61.8	236	52,965	11.5	66.5	241
160	12,000	52,692	10.9	72.7	227	52,824	10.6	77.0	232
120	10,000	50,747	9.1	81.8	197	51,115	8.5	85.6	201
30	7,500	44,782	6.8	88.6	115	45,793	5.7	91.3	118
20	4,000	43,212	3.6	92.3	111	43,970	2.9	94.2	113
10	5,000	41,175	4.5	96.8	105	41,662	3.5	97.7	106
0	3,500	37,043	3.2	100.0	93	37,173	2.2	99.8	94

The results of the sample problem are portrayed in figures 1 and 2. Note that in figure 1 area regulation results in 1,100 acres harvested annually, whereas under volume regulation, the area cut annually varies from 923 acres at year 0 to 1,616 acres by the end of the rotation. This variance is caused by the high concentration of volume in the old-growth stands and by the assumption that stands will be cut by age priority. This increasing trend of acres harvested annually is amplified by the scarcity of intermediate age classes and the subsequent drop in yield from old-growth to second-growth stands.

Figure 1.--Comparison of acres to cut annually using area and volume regulation

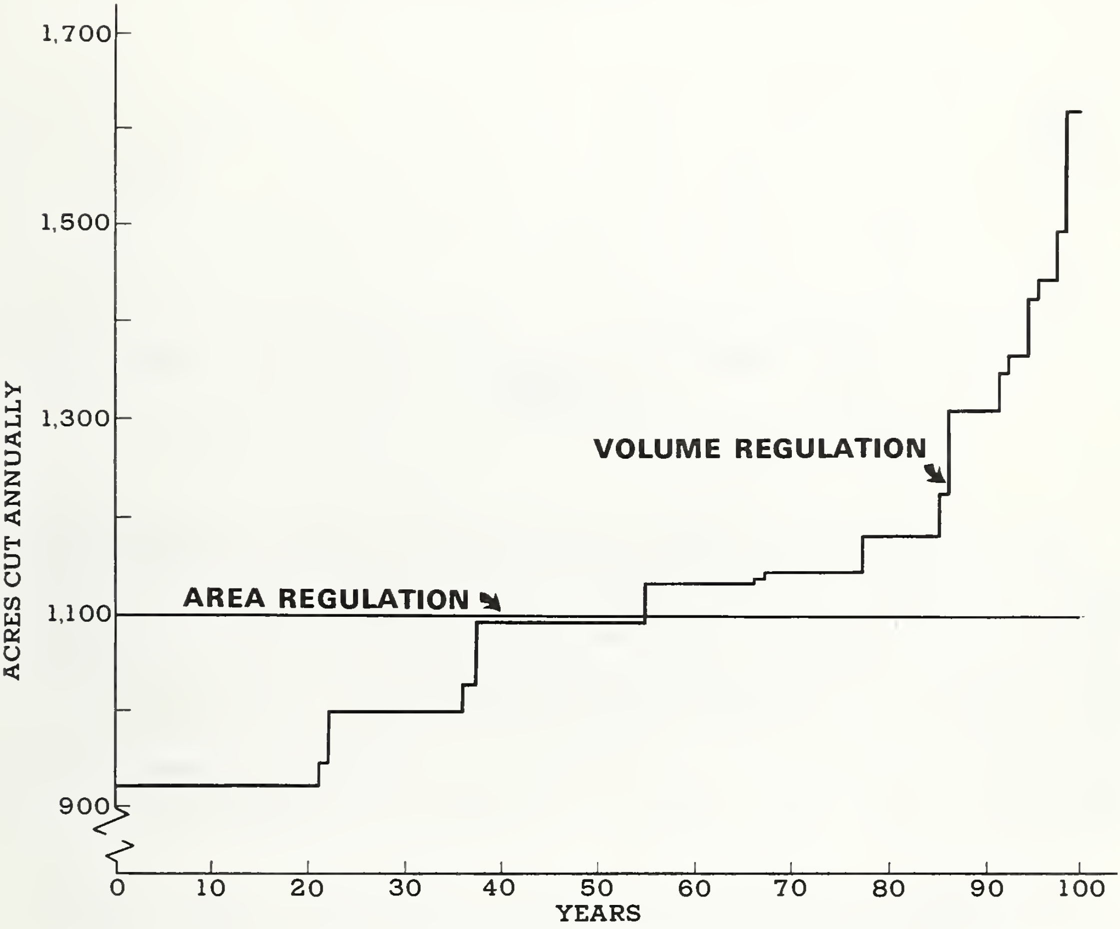
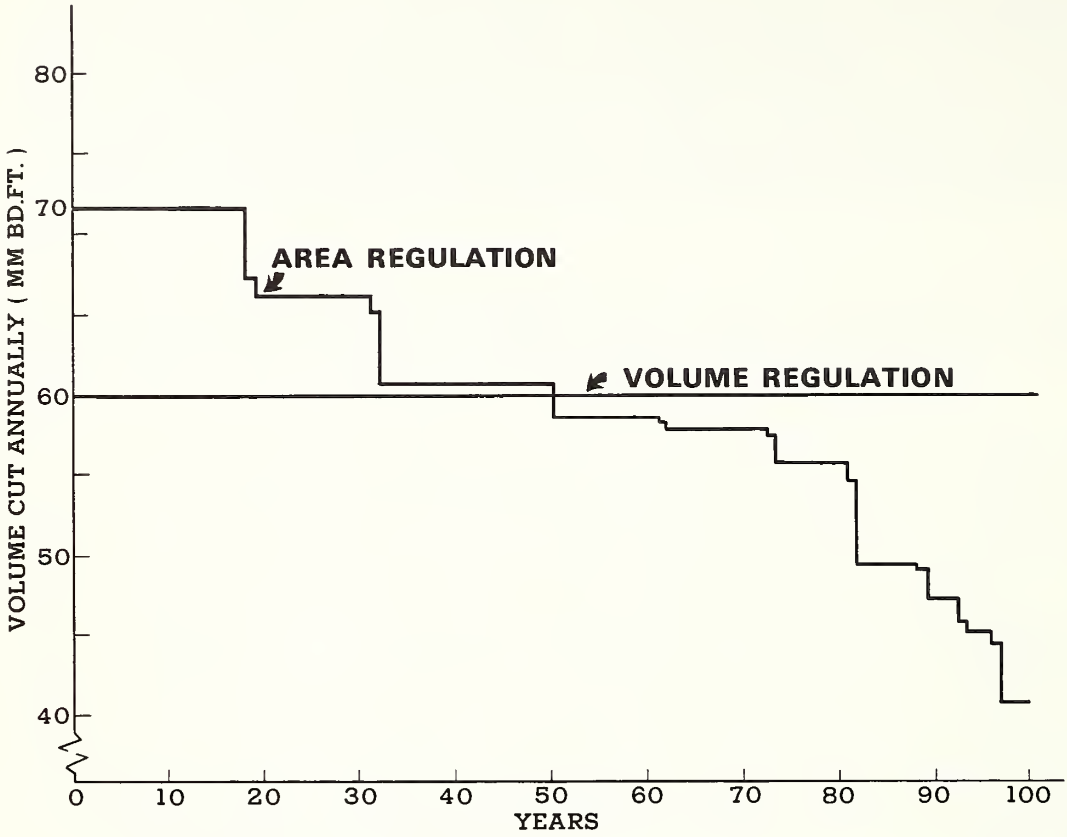


Figure 2.--Comparison of annual allowable cut using area and volume regulation



The volume harvested under area regulation would be greater than that harvested from the same forest by volume regulation for each of the first 50 years. After 50 years, annual harvest would continually drop until the 100th year when the cut would be only 68 percent of the volume produced under a volume regulation system. Again, this comes about because it is assumed that the oldest stands are cut first in both systems, and there is a concentration of volume in old growth. Therefore, if an equal area were to be cut, the volume cut would start higher than under volume regulation and decline as younger stands were reached.

Managers with little concern for fluctuations in annual cut would probably choose area over volume regulation since the forest will become fully regulated after one rotation. For other managers, the choice of a regulatory system is determined, to a large extent, by the progress made in the management unit (e.g., the working circle on the National Forests) toward an even distribution of acreage among rotation age and younger age classes.

If a firm is interested in an even flow of timber during an entire rotation period, volume regulation is likely to be more attractive than area regulation. However, if the distribution of area among age classes is more even, and not concentrated in over-rotation-age timber, then the transition from old-growth to second-growth stands is less abrupt and area regulation may be more attractive.

AVAILABILITY OF THE AREA COMPUTER PROGRAM

Requests for the "User's Manual for AREA Computer Program" (including source program listing) and FORTRAN IV source deck may be addressed to the Director, Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service, P.O. Box 3141, Portland, Oregon 97208.

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